ARKIV FÖR FYSIK Band 1 nr 26

Read 12 January 1949

Reports from the Conference of the Swedish National Committee for Physics in 1948

By Erik Hulthén and Erik Rudberg

Under the auspices of the Swedish National Committee for Physics a general conference[1] on physics was held in Stockholm and Upsala on October 4–6, 1948. Over a hundred scientists from Swedish research institutions attended the meeting, which was honoured by the presence of distinguished visiting physicists from Denmark, Finland, Norway, Germany, Great Britain, Austria and U. S. A. As guest lecturer, invited by the Swedish Advisory Committee for Science, Professor C. F. Powell gave two papers: "Technical Features of the Photographic Method in Nuclear and Cosmic-Ray Physics," and "Experiments on the Meson of the Cosmic Radiation with the Photographic Method." On the second day the conference convened at Upsala, where also experimental work now in progress was shown in the laboratories for physics, for physical chemistry and for high tension research. The third day's sessions were held at The Royal Institute of Technology, where the electronics laboratory, the pressure-insulated Van de Graaff generator and the work of the Concrete Institute were demonstrated, and at the Nobel Institute for Experimental Physics, where the various laboratories for atomic and nuclear research were visited.

A number of contributed papers were presented for discussion in the sessions. Short abstracts of these papers are published in this report, grouped in the same order in which they appeared on the conference programme.

B. Edlén, Physical Institute, University of Lund.

The green mercury line as the ultimate standard of length

The present situation regarding the old question of defining the standard of length in terms of light waves is briefly stated on the basis of the recent report by Dr. Meggers, President of Commission 14 of the International Astronomical Union. Through the production of isotopically pure Hg^{198} in sizeable quantities and the subsequent development of a suitable light source at the National Bureau of Standards the stage has been set for adopting the green line of Hg^{198} as the primary standard of wavelength as well as the ultimate standard of length.

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[1] Secretary of the Conference: Dr. S. Benner, Radiofysiska Institutionen, Stockholm 60.

E. INGELSTAM, Department of Physics, Royal Institute of Technology, Stockholm.

Report from the meeting in Delft, July 12th to 17th, 1948, of the International Commission of Optics

Concerning the organization of the C. I. O. and the Delft Conference the reporter refers to *Elementa*, Sept. 1948, Vol. 31, page 172 (in Swedish), or, for monographs, to the C. I. O. Documents (can be obtained from the General Secretary Prof. P. FLEURY, Institut d'Optique, Paris, or, in Sweden, from the reporter). This report contains notes of Presidents and Bureau, comments on the programme and its limitations, and especially the present activity. The different National Committees work with special common problems, with which they have been charged. The Swedish Committee devotes itself to a survey of the need for ruled gratings, the present possibilities of having them manufactured, and some common quality tests.

CARL-ERIK FRÖBERG, Department of Theoretical Physics, University of Lund.

On large scale computing machinery and its domains of application

Computing machines can be divided into two large groups: digital machines and analogue machines. The digital machines attract special attention since they can be used for solution of very general problems. The analogue machines on the other hand are best suited for a rapid solution of certain special problems. The structure of a digital machine is essentially determined by the internal fast memory. At the present time there does not seem to be more than three possibilities in this respect: the mercury delay line (acoustic), rotating drums (magnetic) and cathode ray tubes or selectrons (electrostatic). At long sight the electrostatic memory seems to be the most promising, being extremely fast and working parallel in principle.

With the aid of large scale computing machinery it will be possible to tackle *e. g.* non-linear ordinary and partial differential equations, integral equations, problems in algebraic number-theory and group-theory and systems of linear and non-linear equations of high order. Such problems arise in hydrodynamics, atomic theory, meteorology, statistics, economics and other fields. There can be no doubt that large scale computing machinery is a new and very efficient tool in applied mathematics.

Y. ÖHMAN, Royal Observatory, Stockholm.

Spectroheliographic work at the Stockholm Observatory

The well established relationship between certain phenomena on the sun and ionospheric and magnetic disturbances has made it desirable to undertake regular solar work also in this country. A grant from "Statens Naturvetenskapliga Forskningsråd" has made possible the construction at the observatory of a small spectroheliograph. The instrument consists of a grating[1] spectrograph ($f = 170$ cm) of the Littrow type with two symmetrically placed slits, one on each side of the tube. The whole spectrograph can be moved perpendicular to the incident beam of light (lead driving weights) and the speed is controlled by a hydraulic arrangement.

The instrument is mainly intended for the use of small images of the sun in order to obtain rapid recordings. Though the diameter of the image is only 16 mm and the dispersion only 9 Å/mm it is well possible to obtain in Hα good tracings of flares, chromospheric faculae and filaments.

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[1] Siegbahn plane grating.

The work with this instrument is only part of a more general routine work, including direct photography of the sun in ultraviolet light and photographic recording of prominences at the limb with a polarizing monochromator. The ultraviolet photographs are made with a Schott UG 2 filter, taking out about 200 Ångström of the spectrum in the H and K region. With this filter the faculae can be traced over the whole image of the sun and not only close to the limb as on ordinary photographs.

Solar data obtained are distributed twice a week to several Swedish institutions dealing with ionospheric disturbances and related problems. The work is done by me in cooperation with Mr. L. Dahlmark of the Stockholm University.

L. Stigmark, Department of Physics, University of Lund.

Determination of the charge of the electron by the shot-effect

Experimental investigations have been carried out concerning the shot-effect in a saturated diode, connected in series with a tuned circuit. The fluctuations in this circuit have been measured with a thermocouple after amplification in an amplifier having flat response for all frequencies present in the fluctuation. The amplification is evaluated by replacing the shot-voltage with a known RF-voltage. The measurements have been made at a frequency of 600 kc/s. The values of the charge of the electron are computed from Schottky's equation. The precision has been increased compared with earlier determinations according to this method.

Lennart Minnhagen, Department of Physics, University of Lund.

A cloud-chamber investigation of the disintegration of lithium by slow neutrons; deductions concerning the energy-range relations for protons and alpha particles

The ranges of the tritons and alpha particles formed in the slow neutron reaction

$${}^{6}_{3}\mathrm{Li} + {}^{1}_{0}\mathrm{n} = {}^{4}_{2}\mathrm{He} + {}^{3}_{1}\mathrm{H} + \mathrm{Q}$$

have been measured in a 25 cm cloud-chamber. The following N. T. P.-mean ranges were found:

$$R_{\alpha} = 10.4 \pm 0.2 \text{ mm}$$

$$R_{^3\mathrm{H}} = 60.0 \pm 0.6 \text{ mm}$$

The Q value derived from R_{α} and the energy-range relation for α-particles (Cornell 1938) and the Q value derived from $R_{^3\mathrm{H}}$ and the energy-range relation for protons (Cornell 1937 revised) disagree; and they are not in accordance with mass spectroscopic data and with data from other nuclear reactions. The discrepancy suggests that the energy given by the revised proton relation for 20 mm protons should be reduced by about 5% and the energy given by the alpha relation for 10 mm alpha particles perhaps slightly increased.

This investigation has been performed at the Institute for Theoretical Physics, Copenhagen, together with Dr. J. K. Bøggild.

TORBJÖRN VESTERMARK, Department of Theoretical Chemistry, Royal Institute of Technology, Stockholm.

Some experiences concerning the absorption of beta rays in solid and liquid matter

The absorption of beta rays is of interest from the point of view of technical radiology, but also theoretically there remains much to be explained. Questions regarding the influence of atomic binding (G. FOURNIER, Thèse, Paris 1927) and of colloidal structure are of a special interest from the point of view of physical chemistry.

It is of great importance for the experimental study of these questions to be able to measure very accurately the absorption itself and the changes in it. With Geiger counters of the present resolution, an error in the intensity measurements of 1% can hardly be avoided as too strong preparations cannot be used. — With the ionization method one can go considerably further. We use the method in an "intensity comparator," especially designed for the study of the absorption of beta rays. It consists of two compensation coupled ionization chambers, placed vertically above one another. The active source is placed symmetrically between the chambers and two almost identical pencils are cut out. In one of the pencils a reference substance is placed, the thickness of which can be varied, for example a liquid in a cuve according to O. LAMM with accurately variable thickness of the liquid. The substance, the absorption of which is to be examined, is placed in the other pencil. — The difference between the two ionization currents enters a d–c amplifier (electrometer tube FP–54). By means of these arrangements it is possible to measure the absorption of a substance in terms of the reference substance. It is also possible to measure eventual transmission changes in layers where chemical reactions are going on.

It could be shown that transmission changes occur during the hardening of gypsum. The results are, however, not wholly reproducible, probably due to the difficulty of avoiding changes of form of the gypsum layer during hardening. At least after 20 minutes have elapsed after mixing, however, all curves show a decrease of beta ray transmission, the total change being of the order of a few per cent. — We used 0.2 mC P^{32} in these experiments and gypsum layers 150 mg/cm² thick. We could observe as small changes of intensity as 0.2 %. Further experiments are going on.

Absorption measurements of the beta rays from P^{32} with a Geiger counter of great opening (60 mm) yielded curves which between 0.06 and 0.3 of the range could be considered as exponential within the limits of errors for particle counting. Using standardized geometrical conditions, the mass absorption coefficient $\frac{\mu}{\varrho}$ in cm²/g and the absorption per electron $\mu_e = \frac{\mu}{\varrho} \cdot \frac{A}{N \cdot Z}$ have been calculated. The empirical relation $\mu_e = 15.8 + 2.07 \cdot Z^{\frac{2}{3}}$ (barns) was found to hold within 4 % for nine metals and three non-metals. (Some of these investigations were performed by Mr. L. G. ERWALL.)

Several technical applications of the absorption of beta rays suggest themselves, for instance concentration measurements, measurements of the adsorption of gases and vapours on solid substances, corrosion etc.

The P^{32}-preparations have been produced by Forskningsinstitutet för Fysik, Frescati. The investigation is supported by Statens tekniska forskningsråd.

BENGT KLEMAN, Department of Physics, University of Stockholm.

Spectroscopic investigations with a photomultiplier tube

In the Physics Laboratory of the University of Stockholm, experiments are being conducted on the suitability of the photomultiplier tube made commercially by the RCA as a detector in spectroscopic investigations. The aim is to arrive at a handy fitting of the tube and of the automatic recording device pertaining to it, making it convenient as a supplement to the photographic plate in spectroscopic instruments of various types. The following instances where the tube is being tested may be quoted: intensity measurements of fine structure components, determination of the line contour in broadened lines, and measurements of the intensity variation in spectral bands.

BENGT NILSSON, Department of Physics, University of Stockholm.

Band spectrum investigations with hollow cathodes

When examining the band spectra of metal hydrides, the hollow cathode has proved to be very effective and, in certain respects, superior to other sources of light used till now. Using insertion tubes of different metals inside the cathode body, the hydride spectra of these metals have been obtained very pure and with great intensity. Copper, silver, gold, and aluminium have been examined. Next, investigations on the hydride spectra of carbon and the group gallium, indium, and thallium are being planned.

LENNART HULDT, Department of Physics, University of Stockholm.

Spectroscopic investigations of hot gases

Temperature, ionization, and partial pressure of metallic vapours have been determined in electric arcs and acetylene flames by the aid of spectroscopic intensity measurements. The experimental results can be explained assuming thermodynamic equilibrium; they yield information on the suitability of the different light sources for quantitative chemical spectral analysis.

ALBIN LAGERQVIST, Department of Physics, University of Stockholm.

Perturbations in the band spectrum of beryllium oxide

There are a large number of perturbations in the band spectrum of beryllium oxide. By the aid of these, it is possible to follow the energy levels of one of the excited electron states up to the nuclear vibration quantum number $v = 25$ (by band analysis to $v = 13$). In some perturbations there appear extra lines. The intensity ratio between the extra line and the "expected" one has been measured.

LENNART MINNHAGEN, Department of Physics, University of Lund.

Stark effect in argon I

Stark effect displacements of argon I lines have been measured by means of a prism spectrograph with large resolving power and dispersion; accurate measurements have been made on lines for which no effect was found previously or for which only qualitative or uncertain results were available. In some cases all components predicted by theory were resolved.

The Stark effect perturbation on a level is determined by the matrix components of the electric moment in a direction opposite to the electric field and by the energy differences between the perturbed level and the perturbing ones, the matrix components being dependent on the type of coupling. Argon I approaches "pair-coupling" but with certain deviations, which appear in the magnitude of the Stark effect of some levels. To get a measure of these deviations the matrix components have been calculated for different types of coupling and the shifts computed by means of these matrix components and the experimental level values; then the calculated shifts have been compared with those observed. As an example the following matrix component in the pair-coupling case is given (Notation according to Condon and Shortley, The Theory of Atomic Spectra):

$$(J_{\mathrm{I}} n\, s\, l\, K\, J\, M \vdots P \vdots J_{\mathrm{I}} n'\, s\, l+1\, K+1\, J+1\, M)^2 = [(J+1)^2 - M^2] \cdot$$

$$\cdot \frac{(J-s+K+2)\,(J+s+K+3)\,(J-s+K+1)\,(J+s+K+2)}{4\,(J+1)^2\,(2J+1)\,(2J+3)} \cdot$$

$$\cdot \frac{(K-J_{\mathrm{I}}+l+2)\,(K+J_{\mathrm{I}}+l+3)\,(K-J_{\mathrm{I}}+l+1)\,(K+J_{\mathrm{I}}+l+2)}{4\,(K+1)^2\,(2K+1)\,(2K+3)} \cdot$$

$$\cdot \frac{e^2}{4\,(l+1)^2-1} \cdot \left[\int_0^\infty r\, R(n\, l)\, R(n'\, l+1)\, d\, r\right]^2,$$

where J_{I} characterizes the parent level of the ion, $n\, s\, l$ the valence electron and $K\, J\, M$ the whole atom $(\vec{K} = \vec{J}_{\mathrm{I}} + \vec{l})$.

In case of jj-coupling one gets $(J_{\mathrm{I}}\, n\, s\, l\, j\, J\, M \vdots P \vdots J_{\mathrm{I}}\, n'\, s\, l+1\, j+1\, J+1\, M)^2$ from the above expression by the following changes of the quantum numbers: $s \rightarrow J_{\mathrm{I}}$, $J_{\mathrm{I}} \rightarrow s$, $K \rightarrow j$ and, similarly, for LS-coupling one gets $(L_{\mathrm{I}}\, n\, s\, l\, S\, L\, J\, M \vdots P \vdots L_{\mathrm{I}}\, n'\, s\, l+1\, S\, L+1\, J+1\, M)^2$ by the changes: $s \rightarrow S$, $K \rightarrow L$, $J_{\mathrm{I}} \rightarrow L_{\mathrm{I}}$.

Kurt Lidén, Department of Physics, University of Lund.

The arc spectrum of fluorine, F I

The arc spectrum of F I has been completely reinvestigated from the vacuum ultraviolet to the photographic limit in the infrared, using modified Schüler hollow cathode tubes as light sources. In a helium discharge the F I spectrum is excited very well with a charge of lithium fluoride, LiF, in the hollow cathode or with a continuous supply of the gas sulphur hexafluoride, SF_6. A grazing incidence vacuum spectrograph with a 1.5 m concave grating has been used for the region 500 Å–2400 Å, recorded on Ilford Q 2 plates. The dispersion at 900 Å in the first order is 4.0 Å/mm. The region 2000 Å–4000 Å has been examined with the Hilger automatic large quartz and glass prism spectrograph E 478 and the region 3500 Å–12 000 Å with a 6.5 m Rowland grating in Wadsworth mounting, giving an average dispersion of 7.6 Å/mm in the first order.

About 250 new lines have been observed from 680 Å to 11 551 Å. Only 91 lines were known before. The analysis greatly extends the F I energy level system. The series limit has been computed from several series with at least three members. The accurate value of the ground state, $^2P_{3/2}$, is $140\,520 \pm 2$ cm^{-1}, corresponding to an ionization potential of 17.417 volts.

CARL BENEDICKS, Stockholm.

Influence of liquids on tensile strength and dimensions of a solid body

("Wetting Effect", "Liquostriction")

A new interpretation of the conception surface tension has been given: if a condensed phase possesses a free limiting surface, it must be expected that this possesses a *surplus of attracting* (cohesion) *forces.* This surplus is due to the cohesion forces which would be expected to emanate perpendicularly to the surface, actually being bound by the neighbouring atoms in the surface. The surplus of cohesion forces in the surface may be looked upon as being the *surface tension* of the condensed phase.

If this be accepted, the following conclusions may be drawn.

A. If a wetting, "normal" liquid is brought into contact with the surface of a solid, the surface tension of this, i. e. the cohesion forces in the surface, *must diminish.* This signifies a *decrease of the (bending) tensile strength of the solid.*

In certain cases, however, the liquid may be adsorbed on the solid surface; this might possibly cause an increase of the surface tension.

B. The decrease of the tensile strength must be expected to depend on the *surface tension of the liquid:* one may expect that the decrease in tensile strength will increase with the surface tension of the liquid.

C. The presence of a wetting liquid causing normally a lessening of the cohesive forces in the surface of the solid, the following conclusion is a necessary one: *the addition of the liquid must cause an expansion of the solid.*

D. This expansion, in first line, must be expected to increase with the *surface tension of the liquid.*

Conclusion A has been amply verified by an investigation of C. BENEDICKS and G. RUBEN (Jernk. Ann. 1945), which has established the existence of the "wetting effect." This effect — originally derived from other premisses — manifested itself as a decrease in tensile strength, due to the presence of water, amounting to 23% for glass and 22% for quenched steel. A strengthening effect was also discovered, amounting to, say, 27% in the case of kerosene for quenched steel.

This wetting — tensile strength effect affords the explanation of quite a number of phenomena, possessing much practical importance.

Conclusion B has been found essentially to hold true for the liquids used, possessing a known surface tension.

Conclusion C gave experimental results which, when exposed at the *Pittsburgh International Conference of Surface Reactions,* June 1948 (Pittsburgh 12, Pa, Corrosion Publishing Co), were received with great interest. As a matter of fact, no considerable difficulties were encountered when using a suitable dilatometer — in which a C. E. JOHANSSON's mikrokator acted as indicator, with a pulling stress of about 2 grams. A nearly horisontal fine wire was carefully immersed in water. The experiments at first were made (by R. HÄRDÉN) on silica fibre, where the temperature has a very slight influence. Diameter of the fibre about 0.030 mm; length used 250 mm. Without exception, a reversible expansion was found to occur at the wetting. The magnitude of the expansion was found to be 0.0027 mm.

The existence of this new phenomenon, designated as *liquostriction*, was established by numerous experiments on silica fibres, but also on metals — in preference platinum. In the latter case precautions had to be taken for holding the temperature invariable.

As for conclusion D: similar experiments using a few other liquids, were found to prove that the magnitude of the liquostriction increases with their surface tensions, as expected.

Thanks to these results, new possibilities appear for the study of the cohesion forces of solid bodies.

GÖRAN BESKOW, Department of Theoretical Physics, University of Stockholm.

On the statistical distribution of atomic nuclei in stellar models in thermal equilibrium at 0.5—2 Mev

Earlier calculations of the equilibrium distribution at 1 Mev with regard to gravitation[1], reviewed by TREFFENBERG at the conference of physics in 1947, resulted in stellar models, showing great resemblance with now existing stars as regards total distribution of elements and total mass (≈ 40 sun masses). In studying the influence of the equilibrium temperature on the distribution, several models at 0.5 Mev have recently been calculated. In these models the main features of the distribution of nuclei are preserved. The masses are somewhat smaller (1–10 sun masses), which may seem favourable, but at the same time the contents of some stable nuclei in the region carbon–silicon is too small. The results hitherto derived, compared with empirical data and preliminary considerations on higher temperatures, seem to speak in favour of an equilibrium temperature near 1 Mev (above rather than below) as the most suitable for a distribution of elements corresponding to the present state.

J. O. LINDE, Department of Physics, Royal Institute of Technology, Stockholm.

Investigation on the critical resolved shear stress for some metallic single crystals

Single crystals of copper and some binary dilute copper alloys have been produced from the fused mass in the form of rods, about 4 mm in diameter and 70 mm in length. For the rods the critical shear stress has been determined by using a testing machine of commercial type in combination with a resistance strain gauge of special construction for the measurements of the yield point. The strain gauge was pasted on the rods and connected to an electrical circuit which made the reading of strains of 10^{-5} possible. The orientation of the crystal axes in the rods was found by taking

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[1] BESKOW and TREFFENBERG, On the So-called Prestellar State of Matter and the Abundance Distribution of Chemical Elements, Part II, Ark. f. mat., astr. o. fys. 34 A, N:o 17, 1947.

X-ray rotation photographs. The results show that the critical shear stress increases very strongly with the concentration of the dissolved element. Different b elements as In, Sn, and Sb give a rather similar increase of the critical shear stress calculated for one atom per cent of the solutes. For Mn as solute, the corresponding figure is much lower. The investigation will be continued on other alloy combinations.

J. NYSTRÖM, Department of Physics, Royal Institute of Technology, Stockholm.

Calorimetric determination of the evolution of heat during fast transformations in alloys

The evolution of heat is measured on a wire placed in a thermostat at the appropriate temperature. By means of an electric current through the specimen this is heated to a temperature sufficiently high for homogenizing. When the current is broken the specimen obtains the temperature of the thermostat, and when the transformation begins, the temperature rises again. The increase in temperature is measured with a number of thermocouples connected in series and fixed to the specimen by means of silicon varnish. For calibration the increase in temperature is measured when a known current is sent through the specimen. At the examination of precipitation in lead-tin alloys somewhat more than the calculated heat is evolved for high temperatures but only about half of it for low temperatures. This is probably due to internal tensions in the alloys.

S. BERTIL NILSSON, Department of Theoretical Physics, University of Lund.

Analytic continuation applied to the electromagnetic level shift

The method of avoiding divergences in quantum electrodynamics by making use of analytic continuation (according to GUSTAFSON) was reformulated by PAULI in the following way. The quantum conditions for the field are altered by introducing a factor $\varphi_\alpha(k)$ equalling, for large values of the photon momentum k, $\varphi_\alpha(k) = (k/M)^{-\alpha}$ (M a constant and α a parameter, $\varphi_\alpha \equiv 1$ for $\alpha = 0$). Then an elimination of non-logarithmic singularities can be effected.[1] Now, in accordance with a suggestion by RIESZ, it is possible to remove logarithmic divergences too if φ_α is taken to be the real part of the expression above, the parameter α, from values with a positive real part, ultimately tending to zero along the imaginary axis.

This form of the theory has so far been used in the non-relativistic approximation to calculate the energy levels of the hydrogen atom, taking into account the reaction of the electromagnetic field. The calculation is similar to that given by BETHE (Phys. Rev. *72*, 339, 1947), except for the integration over k being now extended to infinity. Granting corresponding approximations, the result for the level shift is the same (BETHE's cut-off momentum K is however replaced by the constant M contained in φ_α, which leaves room for a certain arbitrariness).

BENGT HOLMBERG, Department of Theoretical Physics, University of Lund.

On the interaction of neutrons with electrons

The aim of the investigation[2] is to calculate the interaction between a neutron and an electron in a charged or symmetrical meson theory. The Hamiltonian for a combined meson- and electro-magnetic field contains two terms giving an interaction of this kind.

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[1] Cf. S. B. NILSSON, Phys. Rev. *73*, 903 (1948), q. v. for further references.

[2] B. HOLMBERG, Arkiv för mat., astr. och fysik. Bd 36 A. N:o 6 (1948).

1. $H_{\text{int.}}$, which represents emission (absorption) of mesons and light quanta, pair creation (annihilation) of mesons and also more complex effects, in which mesons and light quanta take part simultaneously.

2. H_{Coulomb}, which represents Coulomb interaction between either an electron and a proton or an electron and a negative meson.

Limiting ourselves to the *static interaction*, only terms containing matrix elements from H_{Coulomb} play any role. The interaction potential comes out as a double integral over the meson frequencies $\varkappa$ and the photon frequencies k. By cutting off $\varkappa$ at high frequencies ($\varkappa < N$), we can, after changing the order of integration, perform the integral over k, and it turns out that the resulting integral is convergent even for $N \to \infty$. The result is (for a pseudoscalar meson field):

$$V_{N,e}(r) = -\frac{c^2 f^2}{6\mu^2}\frac{1}{(2\pi)^3}\frac{e^{-\mu r}}{r}\int_{\mu}^{\infty} d\lambda\, e^{-\lambda r}\frac{\lambda^2 + 3\mu\lambda - \mu^2}{(\mu+\lambda)^2}\sqrt{\lambda^2-\mu^2} =$$

$$= -\frac{e^2 f^2}{6\mu^2}\frac{1}{(2\pi)^3}\left\{\frac{e^{-2\mu r}}{r^3} + 2\mu\frac{e^{-2\mu r}}{r^2} + \frac{9}{2}\mu^2\frac{1}{r}Ei(-2\mu r) + \ldots\right\}$$

i. e. an attractive force, which is singular as r^{-3} at the origin.

Now the constant $b = 4\pi\int_0^\infty V(r)\, r^2\, dr$, which has been experimentally determined by FERMI and MARSHALL[1], gives a measure of the interaction.

We find

$$b = -z\left(\frac{m_e}{\mu}\right)^2 4.51 \cdot 10^{-40}\left\{-Ei(-2\mu r_0) + 0.5196\right\},$$

where we have made a certain cut off at $r = r_0$.

For $z \sim 0.1$ ($\mu r_0 \sim 0.1$) we find that $-b \sim 1$—$2 \cdot 10^{-45}$, i. e. the same order of magnitude as estimated by FERMI and MARSHALL, while their experimental determination gave a value $-b = (0.05 \pm 0.74) \cdot 10^{-45}$.

T. LJUNGGREN, Department of Theoretical Physics, University of Uppsala.

On the diffraction of electromagnetic waves by spherical particles

If the radiation considered has a wavelength much larger than the radius of the sphere, the exact solution given by MIE in 1908 cannot be used for numerical purposes. The investigation reported here, deals with the evaluation problem thus arising.

The slowly convergent series of Mie's formulae are substituted by an integral representation allowing a computation with asymptotic expressions. Thereby a method is used which is new to this problem; the tool is Poisson's summation formula for a finite number of terms. A splitting up of the exact expression in different terms, as performed by DEBYE in the corresponding cylindrical problem, gives an interpretation according to the picture afforded by geometrical optics.

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[1] E. FERMI and L. MARSHALL, Phys. Rev. *72*, 1139 (1947).

In this manner a simple deduction out of the rigorous Mie solution gives a description of the rainbows. The result differs from what has been given before as to the intensity factor. This is essential when we regard a radiation that is not monochromatic.

We also get simple expressions for the diffracted, the reflected and the refracted radiation. A fuller account of this part of the investigation will appear later.

LENNART HANSSON, Department of Theoretical Physics, University of Uppsala.

On a spherical neutron diffusion problem

An iteration method, introduced by FERMI for plane problems of neutron diffusion, can be extended to a systematic approximation method applicable to more general geometries by using WALLER's basic integral equations for the neutron density and the angular distribution. This is exemplified by deriving approximate expressions for the neutron density $M_0(r)$ and the angular distribution in an infinite, non-capturing medium, surrounding a perfectly absorbing sphere. The angular distribution for this case has not been calculated before.

As starting point for the iteration we have chosen

$$r\,M_0(r) = r - r_0$$

i. e. the exact solution for large values of r of the integral equation for the neutron density. A better approximation can be obtained by starting from an approximation obtained by the spherical harmonic method.

This investigation will be published in the Ark. f. Mat., Astr. o. Fys., Bd 36 B N:o 8.

The method has been proposed by Professor WALLER and has been worked out for this case under his direction.

PER-OLOV LÖWDIN, Department of Theoretical Physics, University of Uppsala.

On the occurrence of many-body-forces in molecules and in crystals

A quantum mechanical investigation of the cohesive energy of a system of ions having complete electron shells has been carried out by means of the one-electron-approximation and wave functions of the HEITLER–LONDON type. The analysis shows that the energy is a function of the mutual distances between the nuclei of the ions, but that this function is of a rather complicated form, because it contains terms depending simultaneously on the distances between more than two ions. Hence the character of the cohesive energy formally corresponds to the occurrence of *many-body-forces.*

It seems probable that these many-body-forces are of importance in many problems concerning crystals and molecules. In the theory of ionic crystals it followed from the assumption of central forces (two-body-forces), that the elastic constants c_{ij} $(i, j = 1 \ldots 6)$ must satisfy the six CAUCHY relations $c_{12} = c_{66} \cdots, c_{14} = c_{56} \cdots,$ in contradiction to experience. However, if the cohesive energy instead has the form of a many-body-potential, the CAUCHY relations do not follow, and the number of elastic constants remains complete. By using the self-consistent-fields of the free ions published by HARTREE–HARTREE and FOCK–PETRASHEN, numerical applications have been carried out on some alkali halides, and the theoretical values of the difference $c_{44}-c_{12}$ appear to be in tolerably good agreement with the experimental results known. Hence, for these crystals the many-body-forces seem to give a simple account of the deviation from the single CAUCHY relation: $c_{44} = c_{12}$.

The existence of many-body-forces influences also the theory of stability of different lattice types. The polymorphic transitions occurring for the alkali halides in the region of high pressures have been studied, and numerical applications have been performed.

More details may be found in two papers, "Arkiv f. mat., astr. o. fys. 35 A, n:o 9 and 30 (1947–48)," and in my thesis "A Theoretical Investigation into some Properties of Ionic Crystals, Uppsala 1948."

OLOF BRULIN, Department of Theoretical Physics, University of Stockholm.

On a rigorous determination of the field energy in a simple case of the meson pair theory

In the scalar meson pair theory with scalar interaction with a source $\gamma\,\Omega$ the field U is determined by

$$\Delta U + k^2 U = \gamma\,\Omega\,U$$

where the eigenvalue of the energy $E_k = \hbar\,c\sqrt{k^2+\varkappa^2}$ ($\varkappa$ is proportional to the meson mass).

We consider here only a spherically symmetrical source. We suppose the system to be surrounded by a sphere with the same centre as the source and with a radius tending to infinity. U must be finite inside the sphere and 0 on its surface. $\delta\,(k)$ is the asymptotic phase shift of U. Performing the field quantisation we get a total field energy in the lowest state $= \Sigma\,E_k$. The introduction of a source gives a contribution to the field energy

$$\Delta E = -\frac{1}{\pi}\sum_{0}^{\infty}(2\,l+1)\int_{0}^{\infty}\frac{k_0}{\sqrt{k_0^2+\varkappa^2}}\,\delta\,(k_0)\,d\,k_0$$

$\delta\,(k_0)$ is calculated with $\Omega = \frac{1}{r}$, $\left(\Omega = \frac{1}{r^2}\right)$ and $\Omega = \text{const}$ within some radius and 0 outside it. In all these cases, however, ΔE is infinite, even disregarding terms linear in γ. Thus the well-known divergence difficulties appearing if we assume Ω as a δ-function can not be eliminated by the simple assumption of an extended source.

STIG HJALMARS, Department of Theoretical Physics, University of Stockholm.

On higher relativistic approximations in the meson pair theory

As in current meson theories, *e. g.* that of MØLLER and ROSENFELD, the velocity-dependent forces play an important rôle, it might be of interest to investigate the properties of such forces in the pair theory. As is well known the wave function in the vector meson theory consists of a four-vector U_k and an antisymmetric tensor U_{kl}. The possible pair-interactions between this meson field and nucleons with the Dirac spin-matrices γ_k are of the following types:

$$\gamma_4 \widetilde{U}_k U_k; \quad \gamma_4 \widetilde{U}_{kl} U_{kl}; \quad \gamma_4 \gamma_k \widetilde{U}_{kl} U_l \pm \text{conj. compl.}; \quad \gamma_4 \gamma_k \gamma_l \widetilde{U}_k U_l;$$

$$\gamma_4 \gamma_k \gamma_l \widetilde{U}_{km} U_{lm}; \quad \gamma_4 \gamma_k \gamma_l \gamma_m \widetilde{U}_k U_{lm} \pm \text{conj. compl.}; \quad \gamma_4 \gamma_k \gamma_l \gamma_m \gamma_n \widetilde{U}_{kl} U_{mn}.$$

When we use these interactions for calculating the interaction energy between two nucleons with perturbation theory, we find that, in addition to the velocity-independent forces previously investigated, potential terms appear, which are of the first, second etc. order in the velocities of the nucleons. Any one of the above mentioned interactions alone does not give rise to potentials of the first order in the velocities, as such terms only although not always appear when, in the course of the perturbation, two different interactions are combined. When such terms appear, they always have smaller numerical coefficients and smaller singularities for vanishing distance between the nucleons than the velocity-independent terms. Thus, at least for certain combinations of the interactions, it seems to be justified to use, with a good approximation, only the velocity independent parts of the potential.

G. Brogren, Department of Physics, University of Uppsala.

A new method of investigating X-ray absorption edges in gases

A method of determining absorption edges in gases by means of a Geiger counter and a bent crystal spectrograph has been worked out. The absorption chamber was removed and instead the counter was filled with the gas, the absorption of which was to be investigated. Comparative recordings of the spectra of argon and chlorine (in amyl chloride) have been carried out, by doing which both the new method and the one with an absorption chamber hitherto employed were utilized. The two methods agreed very well in their results, but the new method proved to be superior to the old one since the intensity in the spectral regions in question was about five times greater.

By means of the new method, the X-ray absorption edges of the rare gases were investigated within the wave-length region of 14 500–800 X. U. It has been shown that the recorded secondary structure is due to transitions to unfilled optical levels, the term values of which can be obtained from the spectra of alkaline metals.

Carl Reuterswärd, Department of Physics, University of Uppsala.

A mass spectrometer for isotope analysis of the alkali metals

At the Department of Physics of the University of Uppsala there has been set up an equipment for routine measurements of the isotopic constitution of minute samples of potassium. The ion source consists of a Pt strip, impregnated with the metal according to the method of Brewer.[1] The magnetic analyser is of the semicircular type, consisting of a box made of brass and iron plates which are joined by bolts and made vacuum tight by glyptal lacquer baked at 125° C. The magnet is fed from a large-capacity storage battery. Two multistage oil diffusion pumps in cascade serve for evacuating the analyser and the ion source.

The target current, of the order of magnitude 10^{-10} A, is fed to a d. c. amplifier with a direct-reading output meter. In order to stabilize the output of the ion source, the total emission current, amounting to about 10^{-8} A, is amplified also and acts upon the primary of the Pt strip heating transformer through a pair of thyratron tubes (gas-filled tetrodes) connected in push-pull.[1] This circuit incorporates negative feed-back for the purpose of securing a strictly symmetrical action of the tubes.

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[1] P. Bradt, O. L. Parham & A. K. Brewer, U. S. Bur. Stand. J. Res., 1946, 162.

OLOF BECKMAN, Department of Physics, University of Uppsala.

A generating voltmeter

A generating voltmeter, where the movable system is a vibrating plate, has been constructed for the Van de Graaff machine in the Physical Laboratory at the University of Uppsala.

The vibrating plate is suspended by three piano wires 0.5 mm in diameter and carries the coil of a loud-speaker. The system has a vibration frequency of 700 c/s. Power is fed to the coil from a RC-oscillator for 400–800 c/s. The a. c. voltage developed when the voltmeter plate is exposed to an electric field is proportional to the field strength but is also dependent on the amplitude of the mechanical oscillation. As it is difficult to keep this amplitude constant, it is advantageous to have the voltmeter working on the compensation principle. A compensating d. c. voltage proportional to the high tension to be measured, is applied to a coarse grid, 0.5 mm in front of the vibrating plate.

In order to obtain automatic compensation, the generated a. c. voltage is amplified, rectified and fed to the grid. It is true that the voltmeter will not in this method adjust itself to exact compensation, but if the amplifier gain is sufficient, the error will be negligible. The compensating system will be stable only on one side of the compensation point, but as the alternating tension will be in opposite phase on opposite sides of that point, the rectifier is made phase-sensitive so that only alternating tension of correct phase is rectified.

LARS BECKMAN, Research Institute of National Defence, Stockholm.

An ionization gauge with acoustic signal for leak hunting

The tube is manufactured by the Standard Radiofabrik in Stockholm and is designated S 4101-D. Stabilization of the grid current is provided for. The stabilization is effected by controlling the heating current by a series transformer in the heating circuit. The anode current is measured by a vacuum tube voltmeter. The voltmeter has four different measuring ranges. Anode currents from 0.02 microamp. to 100 microamps can be measured, corresponding to a pressure range from $4 \cdot 10^{-7}$ to $2 \cdot 10^{-3}$ mm Hg.

When leaks are to be searched for in the vacuum system, a frequency modulated oscillator is connected to the anode of the ionization tube. The variations in the anode current are amplified in a direct current amplifier and are then fed to the grid of the oscillator tube, a thyratron. The signal is then amplified in a power amplifier and fed to a loud-speaker. Hereby one person alone will be able to localize the leak by means of ether, lighting gas, etc. When the leak is found a distinct change in the tone will be heard.

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[1] R. B. NELSON & A. K. WING, j:r, Rev. Sci. Instr., *13* (1942) 215.

HANS v. UBISCH, Department of Chemistry, Karolinska Institutet, Stockholm.

The mass-spectrometer of the Department of Chemistry, Karolinska Institutet

The tube is of 60° Nier type, manufactured at Columbia University. A 3-stage oil diffusion pump of pyrex in connection with a trap for dry ice is used for exhaustion. Electrical equipments are carefully stabilised. A new switching device permits the easy selection of any desired mass number, within a sequence of ten successive numbers arbitrarily chosen. Two lantern slides of the spectrometer were shown at the Physics Conference.

The spectrometer has been in use during the last year chiefly for the determination of isotope ratios in biochemical research. The accuracy obtained is about 5‰ for N^{14}/N^{15} and 2‰ for C^{12}/C^{13}.

GÖSTA NILSSON and TORBJÖRN VESTERMARK, Department of Theoretical Chemistry, Royal Institute of Technology, Stockholm.

Some experiments with the Brewer-Madorsky countercurrent electromigration method for concentration of isotopes

A pH controlled cell and a boundary cell have been constructed, essentially after BREWER, MADORSKY *et al.* (U. S. Bur. Stand. J. Res. *38*, 137 (1947), RP 1765). The work has hitherto been limited to potassium isotopes. Both cells have been working with KCl as electrolyte.

In the pH cell the feeding of the cathode compartment with HCl is controlled automatically by an antimony electrode with calomel as reference. In order to get conditions with nearly correct countercurrent and a minimum of salt concentration it was arranged that

$$\frac{c_{\mathrm{KCl}}}{c_{\mathrm{HCl}}} = \frac{t_+}{\varepsilon}.$$

The boundary cell was operated with a packing of a cationic exchanger (Wofatit). Isotopic concentration is of the same order as that reported by Brewer and Madorsky. The greatest isotopic abundance ratio is 23.8±0.5. The ionic exchanger does not seem to have influenced the concentration markedly. We are thus not making use of the isotopic effect in ionic exchange found by Taylor and Urey.

The mass spectrometric analysis has been performed by Lic. C. REUTERSWÄRD, in the Department of Physics, University of Uppsala.

ALLAN BERGSTEDT, Research Institute of National Defence, Stockholm.

A portable radioactivity detector

A portable Geiger-Müller counter for the measurement of gamma radiation has been constructed. It is intended mainly for field use in geological surveys. The detector is battery-operated and consists of two units, a probing unit and a main amplifier. The probing unit contains the Geiger-Müller tube and a first stage amplification. The main amplifier contains a driver stage for an electromechanical recording clock and a high voltage supply for the Geiger-Müller tube and batteries.

The pulses from the Geiger-Müller tube are heard as clicks in headphones which plug into the main amplifier. For the actual measurements an electromechanical recording clock is used. The high voltage supply is of the pulse type in which voltage pulses over an inductance in the plate circuit of a pentode — driven by a saw-tooth wave — are rectified. The saw-tooth voltage is generated by a multivibrator. The transient oscillation caused by the interruption of the current through the pentode has a peak value directly proportional to the plate current at the moment of interruption. The pentode has an automatic bias which tends to compensate the change in plate current due to a change in input voltage.

The Geiger-Müller counter tube is filled with ether and xenon and has a diameter of 15 mm and an active length of 60 mm. At a distance of 1 meter, the detector gives 600 pulses per minute in a radiation field of 0.1 mC. The background is about 50 pulses per minute. The resolution time of the counter without recording clock is 10^{-3} sec.

GUY VON DARDEL, Research Institute of National Defence, Stockholm.

Preliminary announcement of a differential pulse analyzer

A differential pulse analyzer for negative pulses has been constructed. Diodes with successively increasing bias discriminate the pulses according to size in 10 channels. In each channel a trigger is triggered by the pulse and supplies pulses, 30 milliseconds long, to the grids of the output pentode with the mechanical register. A positive pulse is supplied to the control grid and a negative blocking pulse to the suppressor grid from the trigger of the preceding channel. The dead time of the analyzer is limited by the mechanical registers to at least 50 milliseconds. By virtue of a special blocking circuit, however, the lost counts do not influence the form of the pulse size spectrum, provided the interval between successive pulses is greater than 1 millisecond. Pulse sizes up to 200 volts are registered in 10 channels, the width of the channels being 2, 5, or 10 volts. The entire apparatus with power supply is mounted on a standard 19″ × 13″ chassis. The analyzer has as yet only undergone preliminary tests.

ROBERT VESTERGAARD, Research Institute of National Defence, Stockholm.

A pulse generator for the examination of counting devices

When using electronic measuring sets, in particular those dealing with random effects, it is important to have a generator giving controllable, periodical pulses as similar as possible to the actual ones.

The present pulse generator, intended to be used in the construction and control of linear amplifiers, scales, mechanical counters etc., yields the following periodical pulses:

1) A double exponentially decaying pulse, pos. or neg. The separation and the individual amplitudes of the pair is variable, the separation between 10 μs and 50 ms and the amplitudes between 0 and 100 V.

2) Rectangular pulses, pos. or neg., at variable widths between 10 μs and 50 ms.

3) Saw-tooth voltage for the cathode ray oscilloscope, syncronized with the pulses.

All the voltages occur periodically, either governed by the built-in saw-tooth generator or from outside.

At the output it is possible to measure the amplitude of the pulses, and to attenuate them before the application in the ratios 10^{-1}, 10^{-2} . . . 10^{-6}.

B. J. Grabe, Research Institute of National Defence, Stockholm.

About ultrarapid cameras and experiences from using them at the Swedish Research Institute of National Defence

The cameras are mainly of the type employing continuously running film and a shutter system; they are used with or without compensating device for the motion of the film during the exposure. At these rapid lapses short exposure is required and effective illumination is of utmost importance and has been obtained through series of vacuumflashes. Detonation processes have been studied with drum cameras. With a film velocity of 100 meter per second an exposure on each point of the film of about 0.1 μs has been obtained through a shield with a slit of 0.5–2 mm in front of the detonating charge.

C. G. Eckers, Research Institute of National Defence, Stockholm.

Construction-data about some ultrarapid cameras at the Swedish Research Institute of National Defence

A camera has been fabricated with continuous running film and a shutter disc for 225 or 900 frames per second. The motion of the film or the object is not compensated.

For detonation-photographing a drum camera has been made. Maximum film velocity is 100 meter per second.

Tests are for the moment going on with a newly constructed drum camera with a velocity of about 300 meter per second, which seems possible to increase to 400 meter per second. The drum has an internal diameter of 640 mm and is working at 90% of vacuum. As a complement that camera can be furnished with a shutter disc, giving 400 000 frames per second, which has been preliminary tested.

A small handy camera with stepwise film feed at a rate of at least 2000 frames per second, has also been designed.

Tryggve Johansson, Research Institute of National Defence, Stockholm.

Standardised parts for laboratory stands

In connexion with plans being laid for the erection of a new laboratory building for the physics department of Lund university, a study has been made of the most suitable design of laboratory stands and parts for such stands. This work has been continued at the Research institute of national defence. It has been found that considerable advantages can be gained by standardizing the dimensions of certain construction elements, in the first place cylindrical bars, clamps and bolt connexions. In this way it can be achieved that different parts and fixtures are ready, without any further adjustments, to be fastened to all sorts of laboratory supports, such as table stands, optical benches, beams for supporting apparatus between floor and ceiling, frames and consoles, field stands a. s. o. Such standardization also saves time and makes it possible to utilize the stock of parts available more efficiently.

In the first place it is proposed to use for the cylindrical column of table stands a standard diameter of 20 mm with R 3/8″ thread, for the cylindrical part for fastening the clamps a diameter of 12 mm, threaded to W 5/16″, and further to use a quadratic modulus for drilled holes, with a distance of 50 mm between centers, and a hole diameter for W 5/16″ thread, either threaded or with a sliding fit.

As an example of such standardized parts an optical bench may be mentioned, which has been designed according to cinematic principles, with riders, frames and consoles, which can be replaced, partly or completely, by the corresponding parts for the ordinary table stands.

Two lantern slides of the parts for the optical bench and the laboratory table stand were shown at the Physics conference and their versatility demonstrated.

E. INGELSTAM, Department of Physics, Royal Institute of Technology, Stockholm.

Attempts to manufacture semiconductor films by means of evaporation

As a part of the author's investigation concerning spectral absorption qualities in thermistors used as bolometers, which are performed by means of a recently constructed monochromator for the infrared region, attempts are going on to prepare films of the said type. Mr. U. BERGENLID is collaborating with the reporter on this subject. One of the methods of such preparing is evaporation in vacuum. As the material should consist of mixed metal oxides, one of the following two possible procedures can be chosen *viz.*, either to evaporate the oxides directly, or to evaporate the metals first and treat the film afterwards. The conditions for both processes were stated at the Physics conference and the attempts hitherto made were described. In order to follow the increasing thickness of the film and the proportions of the two metals, evaporated simultaneously, it is of a special importance to control the amount of material deposited during the procedure. Methods for this, including resistance measurements and calorimetric analysis, are being worked out.

CARL VICTOR JONSSON, Department of Theoretical Physics, University of Stockholm.

On the field theory of mesons with integer spin

The five-dimensional relativity theory introduces a fifth coordinate x^5 in addition to the room-coordinates x^1, x^2, x^3 and the time-coordinate $x^4 = ict$. The quantity canonically conjugated to x^5 is proportional to the electric charge Ze. In the line element $d\sigma^2 = \sum_{\mu,\nu=1}^{5} \gamma_{\mu\nu}\, dx^\mu\, dx^\nu$ the coefficients $\gamma_{\mu\nu}$ are periodic functions of x^5. The five-dimensional equivalent to the invariant of curvature R in the ordinary relativity theory is denoted by Γ. From those terms in Γ, which are independent of x^5, Einstein's equations for the gravitational field and Maxwell's equations for the electromagnetic field are obtained by the variation $\delta \int \Gamma\, d\omega = 0$. If the $\gamma_{\mu\nu}$ deviate only slightly from their normal values, $\gamma_{\mu\nu} = \delta_{\mu\nu} + \varepsilon \varphi_{\mu\nu}$, where $\varphi_{\mu\nu} = \sum_{Z=-\infty}^{+\infty} \varphi_{\mu\nu}^{(Z)}\, e^{iZ\varkappa x^5}$, there are obtained equations for the $\varphi_{\mu\nu}^{(Z)}$ of the same type as the ordinary wave equations for mesons of integral spin.[1] We suppose now that $Z \neq 0$ ($Z = 0$ corresponds to photons and gravitational quanta). Nine of the fifteen $\varphi_{\mu\nu}$ are independent. An examination of the transformation properties in the rest system shows that they can be divided into three groups. φ_{44} corresponds to a scalar meson (spin 0), φ_{14}, φ_{24}, φ_{34} to a vector meson (spin 1) and φ_{11}, φ_{12}, φ_{13}, φ_{22}, φ_{23}, φ_{33} to a meson of spin 2. Then we can find a function of the quantities $\varphi_{\mu\nu}$ which is invariant under a Lorentz transformation and which in the rest system has the value φ_{44}; four functions, which are transformed as a Lorentz vector with the components φ_{14}, φ_{24}, φ_{34}, 0 in the rest system, and functions which are transformed as a Lorentz tensor of the second range with certain extra conditions and which in the rest system correspond to spin 2. These three groups of functions have just those properties which in the ordinary meson theory belong to mesons of spin 0, 1 and 2 respectively.

B. BRUNO, Department of Theoretical Physics, University of Stockholm.

On the capture of mesons in atomic nuclei

The problem of the capture of mesons in atomic nuclei, which has obtained special actuality through the effect discovered by CONVERSI, PANCINI and PICCIONI, has been treated theoretically by different scientists. These calculations, which have been performed under highly specialized assumptions, suffer however from great uncertainties, mainly because they are based on a one-particle model of the capturing nucleus. In the present investigation the capturing proton is regarded as constituent of an α-particle and the dependence of the results on the wave functions employed has been studied for different forms of the meson theory.

HILDING SLÄTIS, Nobel Institute for Physics, Stockholm.

Experiments on the possibility of increasing the efficiency of gamma counters

The efficiency in recording gamma quanta with GM-counters will be increased by insertion of concentric ring systems of metal between the wire and the cylinder. By means of a potentiometer the ring systems get voltages equal to those, which belong to their place in the undisturbed electric field between the wire and the cylinder. In this way three GM-tubes have been constructed, one of which has 3 ring systems with 24 rings in each system. The efficiency of this counter is 2.5 times that of a conventional counter of the same size. In gamma-gamma-coincidence measurements this means an increase of about 6 times. The resolving time of the new counters is smaller than for a common counter. The efficiency as a function of the angle of incidence of the gamma-radiation has been investigated.

NILS SVARTHOLM, Nobel Institute for Physics, Stockholm.

Focusing of electrically charged particles in crossed electric and magnetic fields

In the high precision mass spectrographs of ASTON, BAINBRIDGE–JORDAN and MATTAUCH–HERZOG, an electric radial sector field is used in connection or series with a magnetic homogeneous field in order to achieve both velocity and direction focusing. In the present note it will be pointed out that velocity focusing can be obtained together with a two-directional or anastigmatic focusing if a magnetic shaped field of cylindrical symmetry is combined with an electric field of special shape. If the field strengths vary with the radius as follows

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[1] O. KLEIN, Ark. f. Mat., Astr. o. Fys., 34 A, N:o 1, 1946.

$$H(r) = H_0 \, [1 + \alpha_1 (r - r_0)/r_0 + \alpha_2 (r - r_0)^2/r_0^2 + \ldots]$$
$$E(r) = E_0 \, [1 + \beta_1 (r - r_0)/r_0 + \beta_2 (r - r_0)^2/r_0^2 + \ldots]$$

and if H_0 and E_0 are such that a particle with mass m, charge e and velocity v_0 can be imposed to follow the circle $r = r_0$, then the condition for velocity focusing is $E_0 = e r_0 H_0^2/4m$ while the condition for two-directional focusing, which occurs after an angle of π radians, is simply $\beta_1 = 2\alpha_1$. The latter condition includes the following interesting special cases:

a) $\alpha_1 = \beta_1 = 0$, where the magnetic field is homogeneous,
b) $\alpha_1 = -\frac{1}{2}$, $\beta_1 = -1$, where the electric field is an ordinary radial field,
c) $\alpha_1 = \frac{1}{4}$, $\beta_1 = \frac{1}{2}$, where directional focusing of the second order occurs if the additional relation $\beta_2 = 2\alpha_2 + \frac{1}{2}$ is fulfilled.

The special advantages which can be gained in applying these principles to the construction of a mass spectrometer of high resolution are being investigated both theoretically and experimentally. A preliminary report of the present matter was given in a letter to Phys. Rev. *74*, 108 (1948).

KAI SIEGBAHN and HILDING SLÄTIS, Nobel Institute for Physics, Stockholm.

An instrument for energy determination of β- and γ-radiation

The instrument consists essentially of an electromagnet and a thoroid shaped GM-counter situated between the pole-pieces. The radioactive sample is introduced through a channel in the upper pole of the magnet. A vacuum pump is connected to a channel in the lower pole-piece, located in front of the other. Through this channel the GM-tube can be filled with the appropriate gas mixture, in this case helium and alcohol. The thoroid tube is separated from the space between the pole-pieces only by a 10 μ Al foil, which does not need to withstand any pressure since the gas mixture is the same on both sides of the foil. The sample, which is located in the center, will see the counter under an appreciable solid angle. If a magnetic field is applied, the paths of the β-particles are bent into circles and at a certain field no electrons hit the Al foil and the counter. The relation between number of counts in the counter and current through the magnet gives roughly an integrated Fermi spectrum. The method offers a possibility of measuring quickly and with exceedingly small activity the upper limit of the β-spectrum. If the sample is covered with an Al cylinder which is sufficiently thick to stop all primary electrons, one can investigate the secondary Comptonelectron spectrum in the same set up. It turns out that a monochromatic γ-radiation gives a curve which is very nearly a straight line which cuts the counter background at a certain point. From this the energy of the γ-radiation can be computed. The γ-intensities required are much smaller than those necessary for energy measurements by other methods. The gas scattering effect which is pronounced at low energies has been examined and the problem of correcting for it has been investigated. The method has been used for a number of β- and γ-ray emitters in different energy regions and the results, after gas scattering correction, agree well with β-spectrometer measurements.

L. MELANDER, Nobel Institute for Physics, Stockholm.

Tritium. Something about its preparation and determination

Fairly large amounts of tritium have been prepared from an old beryllium target previously bombarded with 6.5 MeV deuterons in the cyclotron.

An apparatus for the determination of tritium in water samples has been constructed, partly according to principles given in the literature, partly with the use of simplifying methods. Thus neither the use of a high-vacuum pump, nor that of cooling agents is needed.

The water is reduced with magnesium turnings, and a part of the hydrogen (after dilution with inactive hydrogen if necessary) is introduced into a Geiger-Müller tube together with methane, which has been found to be a good quenching gas in this case. The remaining part of the hydrogen is used for control experiments.

It has been shown that the measured activity is proportional to the amount of tritium present in the counter tube. This holds independent of the total hydrogen pressure and the absolute amount of tritium over large intervals. It has also been shown that the reduction does not change the hydrogen isotopic ratio appreciably.

The accuracy in the determination of tritium in water seems to be about ± 2 %.

A complete description will be published in Acta Chem. Scand. *2* (1948).

NJÅL HOLE, Department of Physics, Norwegian Institute of Technology, Trondheim.

Investigations of isomeric nuclei

An investigation has been made of the decay of metastable states in nuclei of the elements Zr, Rh, Cd, Dy, Hf, Ta, Ir, Pt and Hg.[1, 2] The interpretation of the measurement on Zr was uncertain. In all other cases the metastable state was found to decay by a transition to the ground state under the emission of one or two energy quanta, which were more or less strongly converted.

The 1.5 min isomer of Ir is of special interest as it has been reported that in this case a continuous gamma spectrum is emitted.[3, 4] This would correspond to a model of nuclear isomerism proposed by Sachs. We have therefore investigated this case more closely, but without finding any evidence of a continuous γ-spectrum.

Comparison has been made between the experimental data and the existing theories of internal conversion. As was to be expected, quantitative agreement could not be obtained between theory and experiment. One did, however, find reasonable values for the order of the multipole radiation emitted, by choosing the theoretical value which showed best agreement with the experiments.

Comparison between the theory and the experiments was also made for the energy values of metastable states and for the connection between energies and half-lives.

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[1] N. HOLE, Ark. f. Mat., Astr. o. Fys., 36 A N:o 2 (1948).

[2] N. HOLE, Ark. f. Mat., Astr. o. Fys., 36 A, N:o 9 (1948).

[3] M. GOLDHABER, C. O. MUEHLHAUSE and S. H. TURKEL, Phys. Rev. *71*, 372, (1947).

[4] M. L. GOLDBERGER, Phys. Rev. *73*, 1119 (1948).

NILS HAST, Royal Institute of Technology, Stockholm.

Production of extremely thin metal films

Extremely thin and very resistant metal films, being as thin as 20 Å in the case of Be or Al, can be made by evaporating the metals in question on certain liquid surfaces.

Tryckt den 31 december 1949

Uppsala 1949. Almqvist & Wiksells Boktryckeri AB